ARIZONA TRANSPORTATION RESEARCH CENTER

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US93 BIGHORN SHEEP STUDY: Distribution and Trans-Highway Movements of Desert Bighorn Sheep in Northwestern Arizona

Background

Habitat quality encompasses environmental capability to provide conditions contributing to persistence of wildlife populations. Habitat fragmentation at local and regional scales is a major environmental concern, and conservation efforts should emphasize prevention of loss and fragmentation of habitat for desert bighorn sheep (*Ovis canadensis*). Highways and other anthropogenic constructions may fragment desert bighorn sheep populations and prevent animal movements, reduce habitat connectivity, and impair genetic integrity. Moreover, collisions between vehicles and wildlife on highways result in extensive human deaths, injuries, and property damage. Collisions between vehicles and desert bighorn sheep along a 17-mile segment of U.S. Highway 93 extending south of Hoover Dam (milepost 0) in northwestern Arizona have concerned the Arizona Department of Transportation and wildlife managers. Vehicles along this highway segment killed more than 3 bighorn sheep per year between 1980 and 2002.

Construction began in 2003 to realign U.S. Highway 93 and develop a right-of-way bypass and underpass (mileposts 0 to 3) to alleviate traffic congestion at Hoover Dam, and reduce vehicle collisions with and enhance highway permeability to bighorn sheep. Arizona Department of Transportation also proposed future realignment of the highway right-of-way south of this area (mileposts 3 to 17). These projects recognized the need to improve safety of humans and bighorn sheep, to preserve natural bighorn movement corridors, and to construct highway mitigation features designed to alleviate potential fragmentation of the desert bighorn sheep population.

Highway authorities also recognized the need for scientific data to guide construction of mitigation features to enhance trans-highway connectivity for bighorn sheep. Biologists from Arizona Game and Fish Department conducted research between 2004 and 2006 to evaluate distribution and trans-highway movements of desert bighorn sheep in the highway bypass area and identify key highway

crossing locations in the segment of U.S. Highway 93 proposed for future realignment.

Methods

Biologists captured adult desert bighorn sheep in the vicinity of U.S. Highway 93 between Hoover Dam and 17 miles south during spring and autumn 2004 using net gunning from a helicopter. Biologists attached a Generation III, global positioning satellite (GPS) spread spectrum or a store-on-board VHF satellite telemetry collar on each bighorn. Telemetry collars provided a GPS location fix for each bighorn sheep every 5 hours for 2 years, and then dropped from animals automatically via programmed devices on collars. Biologists conducted aerial telemetry flights monthly between April 2004 and April 2005 to download data from spread spectrum collars and obtain locations for bighorns with VHF collars. They incorporated data obtained during flights and from collars following drop-off into a GIS database, and determined locations and movements and identified areas of highway crossings for each radio-collared bighorn sheep.

Biologists also developed and monitored tracking beds and continually conducted ground observations to supplement telemetry data. Fifty track beds of variable length depending on terrain and consisting of fine sand were developed and maintained in areas of historic high and low vehicle collisions with bighorns, and in areas based on data from ground observations. Track beds were placed south along both sides of the highway from the bypass construction area, and were monitored and refurbished at about 3-week intervals. Monitoring involved counting number and noting directional movement of bighorn sheep track sets (single or multiple tracks). Biologists conducted ground observations continually, and recorded date, location, number and group size, gender of adults, presence/absence of lambs, and on which side of the highway observations occurred.

Analysis of GPS data divided the 17-mile highway segment below Hoover Dam into sequential 1-mile and quarter-mile sections, and delineated buffer zones paralleling the highway and extending 0 to 100 meters and 100 to 250 meters on both sides of the highway. Biologists also identified locations of centers of activity for each collared and for groups of bighorn sheep within the area of proposed highway realignment between mileposts 3 and 17. Centers of activity were defined as centrally clustered locations of GPS fixes within a 250-meter buffer zone along each side of the highway. Biologists also calculated and mapped terrain features of the study area using a GIS database.

Results

Biologists estimated that radio-collars were placed on at least 15 % of adult bighorn sheep counted on the study area during previous aerial surveys. Radio-collars provided data for 34 desert bighorn sheep, including 73,496 individual GPS locations for 23 females and 11 males. Radio-collared bighorn sheep, whether or not they crossed the highway, were broadly distributed throughout the study area, and many animals approached but did not cross the highway. U.S. Highway 93 presented a barrier to desert bighorn sheep, in that fewer than expected GPS fixes occurred within the buffer zone extending parallel to and 100 meters from both sides of the roadway. The highway also represented the outer boundaries of home ranges of many individual bighorns.

However, the highway right-of-way did not preclude trans-highway movements by bighorns. Based on locations of GPS fixes, biologists documented 345 highway crossings by bighorn sheep; 232 crossings occurred in the area of highway bypass construction, and 113 crossings occurred within the area of proposed future highway realignment. Forty one percent of radio-collared bighorn sheep crossed the highway. Most males crossed the highway within 8 miles, and most females crossed within 5 miles, below Hoover Dam The numbers of females and males that crossed the highway declined southward from Hoover Dam. Highway crossing locations were not distributed randomly within the area of proposed realignment of the right-of-way between 3 and 17 miles south of the dam.

Biologists identified 5 continuous, linear, elevated guide-ways (CLEGs) that corresponded with ridgelines where bighorn sheep concentrated activities and trans-highway movements. These CLEGs provided connectivity to rugged terrain extending across the highway and were located on or near ridges at mileposts 3.3, 5.1, 7.7, 12.2, and 15.3 between highway mileposts 3 and 17.

Thirty four percent of track beds registered bighorn sheep track sets. Track beds located at mileposts 3.2–3.3, 5.3–5.6, and 7.7–7.9 accounted for 71 % (42/59) of track sets observed, and other track beds within one-quarter mile of these locations accounted for 29 % (17/59). Biologists observed 574 bighorn sheep during ground surveys, including unknown repetitive observations; 427 animals were observed adjacent to U.S. Highway 93. Number of bighorn sheep observed per mile declined southward along U.S. Highway 93 below Hoover Dam.

Biologists observed 33 single animals during ground surveys, and 100 groups consisted of two or more bighorns; groups observed averaged 4.4 animals. Data from telemetry, track beds, and ground observations confirmed highest abundance of bighorn sheep between Hoover Dam and about milepost 6.

Conclusions and Recommendations

Until recent years, there has been little collaboration between biologists and engineers to resolve mutual wildlife-highway dilemmas. One factor affecting paucity of collaboration efforts has been a lack of accepted methods for evaluating potential impacts of roadways on wildlife habitats and for developing mitigation structures. Creating roads and highways that ensure safety yet are permeable to wildlife benefits humans and wildlife. Permeability is key to maintaining life cycles and populations of wildlife in environments dominated by man-made obstacles.

Little rigorous research historically has been conducted regarding design, placement, and effectiveness of highway crossing structures for wildlife, including desert bighorn sheep. Location of crossing structures and use of right-of-way directive fencing are critical aspects in constructing highway mitigation features. Use of GPS and GIS technology allows detailed analysis of effects of highways on wildlife and placement of crossing structures at a level of accuracy not previously possible.

Although U.S. Highway 93 presented a barrier to trans-highway movements of desert bighorn sheep, it did not totally prevent such movements. Biologists found that bighorns readily

traveled through the underpass associated with highway bypass realignment to mitigate traffic congestion at Hoover Dam. This finding suggests that desert bighorn sheep will use underpass structures for trans-highway movements if they are properly designed and located.

Construction of fencing throughout and along both sides of the 17 mile highway corridor will restrict bighorn sheep from entering the highway right-of-way or crossing U.S. Highway 93 except at areas with constructed mitigation features. If a bighorn sheep does find entry into the right-of-way, strategically placed out-jumps designed to prevent entry will allow exit. If mitigation features such as underpasses or overpasses are to be effective, appropriate design and location are critical. No information is available directly relating to design of highway crossing structures for desert bighorn sheep, but biologists made several recommendations.

Underpasses are promising for desert bighorn sheep if they are about 40 feet wide, 12 feet high, conform to ridgelines and known highway crossing locations as closely as possible, avoid washes, and provide natural or familiar substrate (e.g., soil substrate, no exposed rip-rap or large rocks) and good visibility through both sides for approaching animals. Sloped sides that are too loose or steep may impede use of underpasses, and directive right-of-way fencing designed to provide a more natural entry pathway to structures is critical.

Construction of overpasses at some locations might prove to be more desirable to engineers than construction of underpasses. No information is available directly relating to use of overpasses by desert bighorn sheep. Biologists suggest that overpasses also should conform to ridgelines and known highway crossing locations as closely as possible, provide natural or familiar substrate and good visibility through both sides, and be at least about 150 feet wide.

Movements of desert bighorn sheep tend to occur within traditional routes usually associated with more rugged terrain, and strong social ties between offspring and parents promote a highly regular pattern of seasonal movements. Biologists concluded that the newly constructed underpass located between mileposts 0 and 3 provided highway permeability to and was readily used by bighorn sheep.

Biologists also found that locations used by desert bighorn sheep to cross U.S. Highway 93 in the area of proposed right-of-way realignment between mileposts 3 and 17 were not distributed randomly. Data from telemetry, ground observations, and track beds were consistent in identifying locations of concentrated highway crossing areas. Bighorn sheep concentrated their activities and trans-highway movements within the area of proposed right-of-way realignment at about mileposts 3.3, 5.1, 7.7, 12.2, and 15.3. Ridgelines and more rugged terrain at these locations extended across the highway and provided good habitat connectivity. Biologists recommended that construction of underpasses or overpasses at these locations should facilitate right-of-way crossings and highway permeability for the desert bighorn sheep population.

The full report: US93 BIGHORN SHEEP STUDY: Distribution and Trans-highway Movements of Desert Bighorn Sheep in Northwestern Arizona, by Ted McKinney and Thorry Smith, Arizona Game & Fish Department (Arizona Department of Transportation, report number FHWA-AZ-07-576, published January 2007) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.